b. SURVEY OF INTERVARIETAL VARIATION IN THE RESISTANCE TO BLAST DISEASE

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1. Varietal difference in blast resistance

119 Cultivated rice varieties and 204 wild or "primitive" strains from tropical and sub-tropical Asian countries collected by Dr. H. I. Oka, and various mutants induced by irraditions, were planted in an experimental field at Tun-shu, Taichung prefecture, where natural infection occurs in both the first and the second crop seasons. The degree of damage by leaf blast was graded into 12 classes on the basis of the proportion of lesion area to total leaf area.

(*1*) *Experiment with cultivated varieties collected from various Asian countries.*

The varieties tested varied in a wide range of resistance as shown in Table 1.

Table 1. Variation in blast resistance of varieties from different countries

	Localities	Disease index Number											Total
		0	1	2	3	4	5	6	7	8	8.5	8.8	9	
1st crop 1959	Indochina	5	5						1					11
	India & Siam	10	6						1					17
	Celebes	1	3	2		1			1					8
	Indonesia	1	2	1			1	2						7
	Philippines	3	6				1	2	1					12
	Formosa (Native)	4	2		2	1			1					10
	Formosa (Ponlai)							1	5	4				10
	China mainland	1	5	1		1			2	4	1			15
	Japan	1	1			1	2		4	2				11
	Indochina	12	1						1					14
1st crop 1960	India & Siam	11	2	1			1	2						17
	Celebes	4	2						1					7
	Indonesia	4	2							1				7
	Philippines	3	2			1	3							9
	Formosa (Native)	6		1		2	2	1						12
	Formosa (High land)	4						2						6
	China mainland	15	1	2			1	2	3	5				29
	Japan	1	1			2	1	1	1	2				9
2nd crop 1960	Indochina	2	4	3	1	3	1	1	1		1			17
	India & Siam	1	2	3	1	2	2	1	3				1	16
	Celebes		2				1		2				1	6
	Indonesia			1			1	1						3
	Philippines		2			1	2	3	1		1			10
	Burma		1						1					2
	Ceylon				2									2
	Formosa (Native)	3	4		1	1	2		1	1				13
	Formosa (High land)			1		2	1	1	1		1			7
	China mainland		5	6	2	3			2	1	2	5	3	29
	Japan					1	1	1		1	2		3	9

Note: In the 2nd crop of 1959, the infection was not serions enough. The data from this crop were excluded.

As the table shows, varieties from different countries appeared to differ in the resistance to blast. Resistant varieties were mostly found among those from low latitudes, while the susceptible ones mostly from high latitudes. However, both resistant and susceptible varieties could be found in the same country. The Continental (or Indica) type tended to be more resistant than the Insular (or Japanica) type. According to Oka (1953), the Insular type can be further classified into Tropical and Temperate types. More resistant varieties were found in the Tropical Insular group than in the Temperate Insular group, as shown in Table 2.

Table 2. Intervarietal variations in leaf blast resistance in different variety groups

	Variety groups	Didease index number												Total number of varieties
		0	1	2	3	4	5	6	7	8	8.5	8.8	9	
1st crop 1959	Continental	12	14	1	1	2			2					32
	Insular Tropical	2	5	1				4	2	3				17
	Insular Temperate	1	1	1			1		6	2				12
1st crop 1960	Continental	41	4	4		2	4	2	1	1				59
	Insular Tropical	6	5			3	3	3	1	2				23
	Insular Temperate	2				1	1	3	4	4				15
2nd crop 1960	Continental	5	15	11	6	9	5	2	7	1	1	2		64
	Insular Tropical		1	1		1	4	4	4	1	4		3	23
	Insular Temperate					1	1	2	1		1	3	4	13

Note: Continental=Indica type, Insular=Japonica; Oka (1953).

(2) *Experiments with irradiated progeny.*

70 mutant lines derived from irradiated populations of five rices were planted at Tun-shu Experimental field together with their original stock. The results for blast resistance are shown in Table 3. As the table shows, the majority of mutant lines did not differ so much from the unirradiated control in the resistance. However, one line of Taichung No. 65, (thermal neutron treatment, 20 hours) appeared to be highly resistant.

This resistant line was then back crossed with the original stock of Taichung No. 65, The F_1, F_2, and F_3 were grown and the segregation for resistance was studied. The results are also shown in Table 3. As the table shows, the range of variation is fairly wide in both F_2 and F_3 generations. 6 resistant lines were selected from the F_3.

Table 3. Variations in blast resistance in a resistant mutant, its original stock of Taichung No. 65 and their F_2 and F_3

	Crosses	Didease index number												Total
		0	1	2	3	4	5	6	7	8	8.5	8.8	9	
1st crop 1960	Mutant	5	33	6	7	6								57
	F_2		10	3	3	11	19	3	1					50
	Taichung No. 65			1	3	18	48	30						100
2nd crop 1960	Mutant		6	7	14	34	33	6						100
	F_3		2	4	9	26	60	52	42	5				200
	Taichung No. 65									13	59	2	6	80

(3) *Experiments with wild and "primitive" rice varieties.*

The wild rice strains collected from India and Tailand were tested for blast resistance in 1959, and those collected from Africa were tested in 1960. The results are shown in Table 4.

Table 4. Frequency distribution in leaf blast resistance among wild and "primitive" strains

Origin	Crop	Disease index number												Total
		0	1	2	3	4	5	6	7	8	8.5	8.8	9	
India	1st crop 1959	68	44	15	7	8	3	7	13	2				167
	1st crop 1960	79	44	20	9	14	18	20	4	3				211
	2nd crop 1960	7	8	7	2	5	3	3		1				36
Tailand	1st crop 1959	35	6	1	1									43
	1st crop 1960	2	1					1						2
	2nd crop 1960			1					1					2
Africa	1st crop 1950	9	4	1	1									15
	2nd crop 1960	2	4	4	1	4	4	3						22

As the table shows, the strains from India varied in a wide range. Those collected from Tailand were mostly resistant. About half of those from Africa were resistant while the other half showed medium resistance.

(4) *Experiment with different Oryza species.*

A wide variation in leaf blast resistance was found among the *Oryza* species tested as shown in Table 5.

Table 5. Interspecific differences in leaf blast resistance

Name of species	Disease index number	Name of species	Disease index number
O. brevitigulata	5	O. glaberrima (W025)	2
O. lichinger	0	O. glaberrima (W026)	0
O. alta (Suriram)	0	O. glaberrima (W027)	8
O. perennis (Burmis)	1	O. glaberrima (W028)	0
O. longistaninata	4	O. glaberrima (038)	8
O. Perennis (Cubensis)	0	O. glaberrima (039)	7
O. minuta	0	O. glaberrima (W040)	5
O. sativa f spontanea	8	O. glaberrima (W041)	0
O. glaberrima (W024)	8	O. glaberrima (W055)	3

2. Introduction of resistant genes into the Ponlai or Japonica Rice

(A) Progeny test of the cross Taichung No. 65×Kanto No. 55.

In both first and scond crop seasons of 1960, F_3 and F_4 plants were planted together with their parents. Variations in blast reaction in the materials are shown in Table 6. As Table 6 shows, in the first crop of 1960, the majority of F_3 lines showed resistance. 100 lines were then selected from them and the F_4s were grown. In the F_4 generation all selected lines were susceptible or intermediate. Nevertheless, the materials were used for yield trial.

Table 6. Frequency variation in leaf blast resistance in Taichung No. 65×Kanto No. 55

	Crosses	Diseade index number											Total
		0	1	2	3	4	5	6	7	8	8.5	8.8	9	
1st crop 1959	Taichung No. 65		1	2		3								6
	F_3 Taichung No. 65 ×Kanto No. 55	3	36	15	22	20	4							100
	Kanto No. 55		1	4										5
2nd crop 1959	Taichung No. 65									13	59	2	6	80
	F_3 Taichung No. 65 ×Kanto No. 55					5	15	40	111	28	1			200
	Kanto No 55								8	91	1			100

(B) Progeny test in the bulked population of F_5 in the cross of Taichung No. 65×C. I. 1955.

In the 1st crop of 1959, 9 lines from F_5 were bulked and were tested with regard to blast resistance. The susceptible ones were discarded.

(C) Progeny test in the cross between resistant varieties and Ponlai varieties. The progeneis of 11 crosses between Indica and Ponlai varieties and 6 crosses between resistant varieties were surveyed with regard to blast resistance. The cross combinations employed are as follows:

1. JC 148-4 (India)×Chianun-yu No. 242
2. JC 148-4 (India)×Tainan No. 1
3. JC 148-4 (India)×Nunshu No. 20
4. JC 148-4 (India)×Kaoshung No. 27

5. Katakutara (India)×Chianun-yu No. 242
6. Katakutara (India)×Tainan No. 1
7. Katakutara (India)×Kaoshung No. 27
8. Taichung No. 65×JC 148-4
9. Taichung No. 65×JD 73 (Siam)
10. Taichung No. 65×Katakutara
11. Taichung No. 65×JC 178-2 (India)

(b) Crosses between resistant varieties.

1. Maratelli (Italy)×Nunlin No. 12 (Japan)
2. Maratelli (Italy)×CI 9155 (U. S. A.)
3. Maratelli (Italy)×Pi No. 4 (Japan)
4. Noling No. 12×CI 9155
5. Noling No. 12×Pi No. 4
6. CI 9155×Pi No. 4

Table 7. Frequency distribution in leaf blast resistance in crosses between resistant varieties and susceptible Ponlai varieties

Generation	Crosses	Disease indes Number												Total	No. of plant selected
		0	1	2	3	4	5	6	7	8	8.5	8.8	9		
Bc_1F_1	Jc148×Chianun-yu No. 242	6	20	13	5	2	1							47	5
	Jc148×Nunshu No. 20		10	10	4	6	10	8	4	5	3			60	3
	Jc148×Tainan No. 1		1	1	1	2	3	3	1					12	3
	Jc148×Kaoshung No. 27		27	8	4	10	3	3	1					57	5
	Katakutara×Chianun-yu No. 242		5	3	8	4	2	1						23	3
	Katakutara×Tainan No. 1	1	4	10	7	10	2	1						35	2
	Katakutara×Kaoshung No. 27		2	4	4	7	6	5	4					32	2
F_2	Jc148×Chianun-yu No. 242	39	37	9	4	7	10	11	12	3				132	4
	Jc148×Tainan No. 1	10	35	28	4	17	25	11	2					132	8
	Jc148×Numshu No. 20	22	47	18	3	8	12	9	7	1				127	4
	Jc148×Kaoshung No. 27		5	10	3	13	56	24	14	4				129	5
	Katakutara×Chianun-yu No. 242	19	53	22	3	4	7	3	2	5	2	1		121	3
	Katakutara×Tainan No. 1	11	44	11	1	6	17	3	7	1				101	4
	Katakutara×Kaoshung No. 27	6	46	28	24	14	9	3	1	1				132	6
	Taichung No. 65×Jd73	5	24	24	2	25	39	13	11	2				145	2
	Taichung No. 65×Jc148-4	2	17	20	21	33	41	16	6	3				159	12
	Taichung No. 65×Katakutara	54	26	11	12	12	17	6	3					141	7
	Taichung No. 65×Jc178-2	104	19	13	9	7	5	0	2	1				160	5
Ck	Jc148-4							*							
	Katakutara		*												
	Jd73	*													
	Jc178-2						*								
	Taichung No. 65								*						
	Chianun No. 242						*								
	Tainan No. 1							*							
	Numshu No. 20								*						
	Kaoshung No. 27								*						

Note: *……based on lines.

In the first crop of 1960, the F_1 plants of the above listed crosses were back crossed with their parental lines. In the second crop of 1960, the F_1s, F_2s and Bc_1s were planted and resistant ones were selected for the second back-crossing. The results are shown in Table 7.

As Table 7 shows, the resistant plants were more frequently found in F_2 than in Bc_1 and F_1 plants. The resistant plants were selected and were back-crossed again with their parents. The results are shown in Table 8. Crosses between two resistant lines were highly resistant in 4 crosses, but in the other two crosses an intermediate resistance was found, indicating that the genotypes of the parents differed regarding resistance.

Table 8. Variation in blast resistance in the progeny of cross between resistant varieties

Crosses	Disease index number												Total	No. of plant selected
	0	1	2	3	4	5	6	7	8	8.5	8.8	9		
Maratelli×Noling No. 12	51	56	22	14	9	7	2	5	2				168	3
Maratelli×C. I. 9155	49	16	2										67	3
Maratelli×Pi No. 4	31	36	5	4	7	3	2	2					90	4
Noling No. 12×C. I. 9155		1	2		2	7	35	52	60	9	4	6	178	2
Noling No. 12×Pi No. 4	1	6	5	4	25	50	31	32	9			1	164	2
C. I. 9155×Pi No. 4	43	32	5		1	2	2	3					88	6
Ck Maratelli		*												
Ck Noling No. 12					*									
Ck C. I. 9155	*													
Ck Pi No. 4	*													

Note: *……based on lines.

DISCUSSION

Lin: I think the system for determining the degree of infection should be re-examined. The percentage of lesion area has been used up to present. In Japan, the degree of infection is in most cases determined on the basis of lesion type. Therefore, in our future experiments these two systems should be compared.

Hung: I think the system now in use in Japan is a good one. Different types of lesion show characteristics of reaction type, and it is not necessary to take the number of lesions into consideration. I recomend you to use this system in your future studies.

Chiu: Mr. Lin used a number of varieties collected from South-east Asian countries and tested their reactions to blast disease. Is it possible to compare the damage of blast disease on yield of rice in various sub-tropical districts?

Oka: Though the materials used in this experiment covered various counties of tropical Asia, the growing conditions in respective countries are quite different from one another, therefore, can not be compared in one experimental field.

Hsieh: According to your report the index numbers for some varieties are zero. Are these varieties immune to the blast disease?

Lin: According to the definition of index number, zero means immunity but in the present study, slightly infected plants only with a trace of lesion was counted as zero. Therefore, strickly speaking, no immune varieties would be found in this study.

Hsieh: Is there any immune species in wild rice?

Lin: In some species, no trace of infection was found in the first year. I thought, they were immune from blast disease, but in the second year, very small brown spores appeared on the leaves. Generally speaking, most wild species show a high resistance to blast but no real immune type was found within the scope of present study.